ECONOMIES OF SCALE IN CALIFORNIA CLING PEACH PRODUCTION

GERALD W. DEAN and HAROLD O. CARTER

Recent economic conditions in the cling peach industry have made it clear that many operations are too small. The green-drop program, increased wages, and reduced prices make it necessary for some growers to consider these possible adjustments in their operations:

1. Expanding in size
2. Mechanization of pruning, thinning, and harvesting
3. Diversifying cling peach crops with other fruit and nut crops
4. Seeking full-time or part-time employment off the farm
5. Selling the orchard and seeking employment elsewhere

These adjustments will be considered in detail in this bulletin.

This bulletin is the third report in a series of investigations concerning economies of scale in California agricultural production. Earlier studies dealt with economies of scale in the Yolo County cash-crop irrigated area around Woodland and in the Imperial Valley (Giannini Foundation Research Reports 238 and 253).

The present analysis is based on data from several sources. Data on machinery, labor use, yields, and many other aspects of farm organization and operation were collected in a 1959 farm survey in the Yuba City-Marysville area, using the area sampling technique. Supplementary data on cultural practices, varieties, future mechanization, and other aspects of cling peach production were obtained from many informed individuals from the University of California and the cling peach industry. The study also draws freely on many publications of the California Agricultural Experiment Station, the California Agricultural Extension Service, the California Cling Peach Advisory Board, and other miscellaneous sources. Specific sources will be indicated at appropriate points in the report.

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Personal interviews with a sample of cling peach growers in the Yuba City-Marysville area, supplemented with secondary engineering and cost data, revealed the following facts about costs and profits in cling peach production:

1. Under present production practices on cling peach farms, when resources are used to capacity, costs per ton decline as farm size expands up to about 60 acres, then are essentially constant for larger farms. Reductions in costs per ton with increased size result primarily from more complete utilization of fixed overhead machinery and labor. Thus, smaller orchards which use machinery and labor to capacity may have lower costs per ton than larger orchards which use their resources at less than capacity.

2. Level of yields is a tremendously important factor influencing costs per ton. For operations of efficient size, there is a cost difference of about $21 per ton between orchards with low versus high yields. Cling peach orchards with low yields show losses for the entire range of peach prices and orchard sizes considered. On the other hand, orchards of only 20 acres show profits with high yields.

3. Larger operations have the advantage of more blocks of peaches, allowing less year-to-year variation in production due to replacing trees, and permitting full use of tree pullings toward the green-drop requirement.

4. Increases in wage rates sharply increase production costs. For medium-yield orchards of efficient size, any increase in wages would result in losses from the farm operation (assuming peach prices of $58 per ton). However, high-yielding orchards of efficient size could continue to make profits until wages increased up to about 40 per cent.

5. Under mechanization, costs per ton

decrease with increased orchard size up to about 90 to 110 acres, then are nearly constant. Thus, mechanization would substantially increase the size of orchard required for efficient operation.

6. Mechanization results in higher costs per ton than present methods for small farms, and in lower costs per ton for large farms. The break-even point (equal costs per ton for the two methods) is about 55 acres. However, the likely development over time of mechanical harvesting and thinning on a contract basis could lower the costs per ton under mechanization for smaller operators.

7. An increase in wage rates would increase the relative advantage of mechanization. For example, a 25 per cent increase in wage rates would reduce the break-even point between present methods and mechanization to 25 to 30 acres. A 50 per cent increase would further reduce the break-even point to 18 to 20 acres.

8. The percentage of allowable damaged fruit losses from mechanization (as compared to present methods) depends primarily on farm size and wage rates. The percentage of allowable loss increases substantially for larger farms and higher wage rates.

9. Off-farm work, if integrated effectively with the orchard operation, can be an important supplement to the incomes of small growers. An operator could work off-farm full time and still continue to farm up to about 20 acres in his spare time. A grower with a year-around half-time job could handle about 40 acres in this manner.

10. Profit margins in peach production have been sufficiently low to make selling the business a serious alternative for growers with low yields (regardless of size) or with operations of relatively small size.

11. Diversification with several varieties of cling peaches or with other tree fruit and nut crops does not appear to have substantially reduced income variability. Apparently, the incomes of producers who specialize in cling peaches are as stable as those of producers who diversify with additional tree crops.

12. Peach growers, particularly those with small acreages, are generally aware that their operations are now or will be of insufficient size in the near future.

ECONOMICS OF SCALE IN CALIFORNIA CLING PEACH PRODUCTION [1]

By Gerald W. Dean and Harold O. Carter

CALIFORNIA IS the only important producer of cling peaches in the United States. The bearing acreage of cling peaches in California in 1960 was about 51,000 acres. About 80 per cent of this total acreage was located in two areas: 47 per cent in the Modesto district and 34 per cent in the Yuba City-Marysville district. The remaining 19 per cent of

the acreage was about evenly divided between the Stockton and Visalia-Kingsburg districts. Table 1 indicates a substantial increase in total bearing acreage in 1960 and 1961. Furthermore, the acreages in trees coming into bearing in 1962, 1963, and 1964 continue to be relatively high and will probably lead to further increases in bearing acreage in the next few years. High grower prices in the mid-1950's apparently stimulated

[1] Submitted for publication March 2, 1962.

Table 1. Statistics on the California Cling Peach Industry[a]

Year	Bearing acreage (June 1)	Tree removals and adjustments	Plantings (4 years old) coming into bearing following year	Harvested (excludes tonnage green dropped)[b]	Produced (includes estimated tonnage green dropped)[c]	Yield per bearing acre (includes estimated tonnage green dropped)[c]	Seasonal average price received by growers
	acres			tons	tons	tons/acre	dollars/ton
1951............	41,803	1,766	2,626	569,836	569,836	13.6	$77.30
1952............	42,663[d]	3,200	3,620	447,022	525,908	12.3	65.20
1953............	43,083	1,173	1,865	526,396	526,396	12.2	54.80
1954............	43,775[d]	3,266	2,363	442,926	533,646	12.2	54.70
1955............	42,872	2,428	4,302	522,412	522,412	12.2	80.50
1956............	44,746	2,502	4,629	634,774	634,774	14.2	71.00
1957............	46,873[d]	3,422	3,018	521,890	621,298	13.3	64.10
1958............	46,469	1,738	4,198	492,163	492,163	10.6	65.10
1959............	48,929	4,757	6,792	571,413	636,791	13.0	58.80
1960............	50,964[d]	6,251	9,185	592,722	658,242	12.9	55.90
1961............	53,898[d]	3,485[e]	6,247	652,115	692,023	12.8	66.50
1962............	56,660[e]	.....	8,996	....	....	....	.....
1963............	......	.....	4,617	....	....	....	.....
1964............	......	.....	3,186	....	....	....	.....
1965............	......	.....	3,550[e]	....	....	....	.....

[a] Season price data from: California Crop and Livestock Reporting Service, *California Fruit and Nut Crops—Annual Summary, 1955, 1956, 1957; California Fruits—Annual Summary, 1959, 1960, 1961.* All other data from: Cling Peach Advisory Board, *Orchard and Production Survey, 1959–60,* p. 27, April, 1960; *1960–61,* p. 27, April, 1961; *1961–62,* p. 27, April, 1962.
[b] Includes small tonnage from 2- and 3-year-old plantings.
[c] Subject to adjustment for green-drop requirement as follows:

Year	Per cent
1952	15
1954	17
1957	16
1959	10
1960	10

[d] Tree removals as offset to green-drop requirement not deducted until following year.
[e] Estimated; subject to adjustment.

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an unusually large acreage of new plantings which are now entering production. Because of high production, the industry has employed the volume control provision of the cling peach marketing order several times in the past few years. The "green-drop" requirements[2] have been: 1950—15 per cent; 1952—15 per cent; 1954—17 per cent; 1957—16 per cent; 1959—10 per cent; 1960—10 per cent. In all likelihood, some method of volume control will be used to regulate production in the cling peach industry for at least the next few years.

Because of these conditions, California cling peach growers are faced with the prospects of a reduction in tonnage harvested resulting from the green-drop program and also with reduced prices. Although the cling peach price jumped sharply to $71 in 1961 because of intense competition among canners for contracted acreage, it seems unlikely that prices will remain at this level.

SPECIFIC PROBLEMS AND OBJECTIVES

Recent economic conditions in the cling peach industry have made it clear that many operations are too small. A 1952 study[3] indicated that 55 per cent of the California cling peach growers operated ranches of 0 to 10 acres, 24 per cent operated ranches of 10 to 20 acres, 14 per cent operated ranches of 20 to 40 acres, and only 7 per cent operated ranches over 40 acres in size. The size distribution of ranches was similar in the two major producing areas of Yuba City-Marysville and Modesto. A 1959 survey[4] in the Yuba City-Marysville area suggests an upward trend in size since 1952, yet 44 per cent of the farmers interviewed had ranches of under 20 acres in 1958, and another 26 per cent had ranches of 20 to 40 acres in 1958. In 1950, the California Extension Service recommended that a 20-acre peach orchard should be considered minimum size for a family operation.[5] By this criterion, a large number of farms producing peaches are of insufficient size. Furthermore, under present and prospective conditions, the economic size of orchard may well be greater than 20 acres.

Several adjustments, which will be examined in this report, are available to California cling peach growers:

1. Expansion in size in order to obtain economies of large-scale production.

2. Possible mechanization of pruning, thinning, and harvesting to replace present hand methods, under both present and increased wage rates.

3. Diversification of cling peaches with other fruit and nut crops to reduce risk and more fully utilize machinery and equipment.

4. Full-time or part-time off-farm employment for the operator.

5. Selling the orchard and seeking employment elsewhere.

[2] "Green-drop" refers to the industry program of eliminating surplus tonnage by knocking to the ground the green peaches from a determined percentage of trees in each orchard.

[3] Bredo, William, *Production Costs for Cling Peaches in California*, Stanford Research Institute, Stanford, California, June, 1953, p. A–3.

[4] Survey conducted by the authors in 1959.

[5] California Agricultural Extension Service, U. S. Department of Agriculture, and Sutter County, *Thirteenth Sutter Canning Peach Management Study, 1950*, Office of the California Agricultural Extension Service, Yuba City, California.

These adjustment opportunities will be examined with primary reference to the Yuba City-Marysville district. However, a comparison with the Modesto district— the other major production area—provides a basis for generalizing the results to include the bulk of cling peach production in the state.

BASIS OF ANALYSIS

The alternatives facing cling peach producers are compared through budgetary analysis. It is convenient to present a large part of the budgetary results in the form of long run average cost curves. Briefly, the long run average cost curve shows the minimum cost per ton for producing each level of tonnage, under specified assumptions of management, technology, and input prices. Empirically, the long run average cost curve is formed as tangent to the several short run cost curves. For example, each of the hypothetical short run curves $SRAC_1$, $SRAC_2$, $SRAC_3$, and $SRAC_4$ in figure 1 indicates the changes in cost per ton as greater tonnage is produced with some resource such as land or machinery held fixed. In this study, machinery is considered as the fixed resource in the short run. Thus, the short run curves in figure 1 represent costs for successively larger amounts of fixed machinery resources. The long run average cost (LRAC) curve (figure 1) is derived as an envelope (tangency) to the short run curves and,

Fig. 1. Hypothetical short run and long run average unit cost curves for orchards of different sizes

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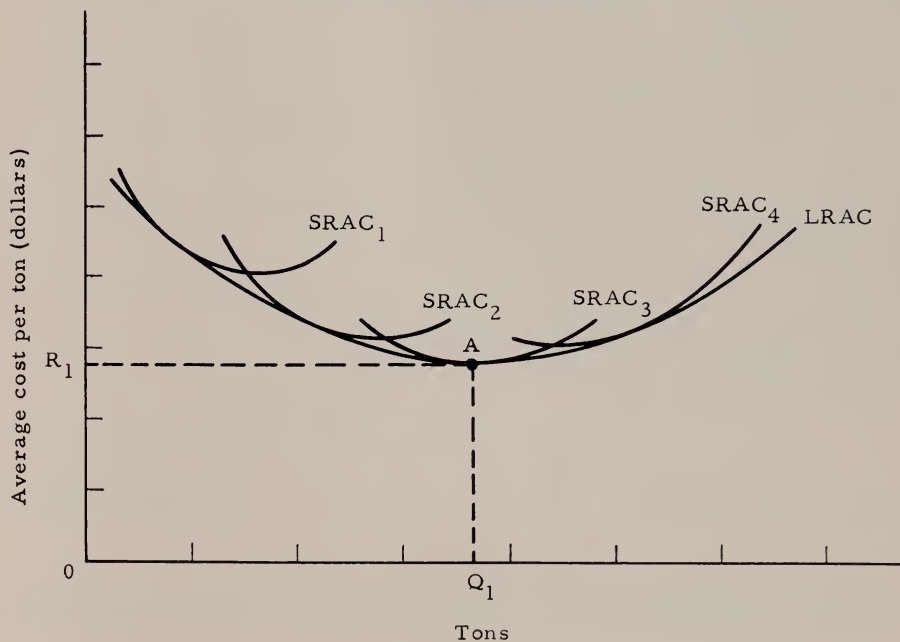
therefore, shows the minimum cost per ton for each level of output with all resources variable. Theoretically, the long run average cost curve is U-shaped, with average costs declining until output reaches Q_1, then increasing. If price per ton fell to R_1, only farms operating at point A could survive in the long run in a competitive industry; all other farms would have higher costs and would there-

fore be operating at losses. However, at prices greater than R_1, farms with outputs larger or smaller than Q_1 might still operate at profits.

Long run average cost curves are used in the following analysis to indicate changes in cost per ton as orchard size increases under given assumptions of yields, cultural practices, prices, and combinations of resources. These as-

Table 2. Machinery and Equipment Assumed for Operations of Different Sizes

Machinery and equipment	Machinery component and farm size (acres)				
	I 0–20	II 20–50	III 50–100	IV 100–300	V 300–600
	number of units				
Pickup truck (½ ton)	1	1	2	3	5
Truck (1½ ton)	0	0	2	1	2
Truck (flatbed)	0	0	0	2	3
Trailers	3	6	3	4	4
Wheel tractors:					
30 hp, gasoline	1	2	0	0	0
30 hp, diesel	0	0	1	2	3
Tracklayers:					
40 hp, diesel	0	1	0	0	0
50 hp, diesel	0	0	1	2	3
Chisel	0	0	0	1	1
Disks:					
9'9''	1	1	0	0	0
10'6''	0	0	2	3	4
Spring-tooth, 10'	1	1	1	1	1
Ridger	1	1	1	2	2
Harrow	1	1	1	1	1
Roller, 11'	0	0	1	1	2
Scraper, 10'	0	0	1	1	1
Toolbar	0	0	0	0	1
Fertilizer spreader, 10'	1	1	1	1	1
Broadcast seeder	1	1	1	1	1
Speed sprayer:					
300 gallon	0	1	0	1	0
500 gallon	0	0	1	1	2
Forklift attachments	0	0	1	2	3
Ladders, props, picking and pruning equipment, shop equipment	$67 investment per acre				
	additional equipment for mechanical handling				
Mechanical harvester (includes 2 shakers, 2 frames + tricycle for pruning)	1	1	1	1(< 120 acres) 2(120–240) 3(240–300)	3(300–450 acres) 4(450–600)
Additional forklifts	1	1	0	0	0

SOURCE: 1959 survey of cling peach producers in Yuba City-Marysville area by authors. Fixed costs for machinery are summarized in table 7.

sumptions are varied to indicate the impact on costs and economic orchard size of yield level, green drop, mechanization, and changes in wage rates.

Machinery and Equipment

As indicated above, machinery is the fixed resource underlying the short run cost curves presented in this study. Based on 1959 survey information, typical machinery combinations for peach farms of different acreages were derived and are presented in table 2. The bottom portion of the table shows the additional equipment required to shift to one form of mechanization described in detail later. The maximum tonnage which can be handled with each set of equipment is determined by requirements at harvest time for tractors, trucks, and trailers (and forklifts for those using bulk han-

dling). Each short run cost curve is extended to this maximum tonnage; however, because of varying yields per acre this maximum tonnage does not always correspond exactly to the upper acreage limit shown. For example, with relatively low yields per acre, machinery component I (table 2) can handle almost 30 acres.

Varieties and Yields

Cling peach varieties are divided by the industry into four maturity groups—extra early, early, late, and extra late. Growers generally plant a number of varieties with differing maturity dates in order to facilitate certain orchard operations, especially thinning and harvesting. On the other hand, each varietal block of peaches must be large enough to permit efficient use of machinery and men.

Table 3. Percentage of Total Acreage Assumed in Each Maturity Group, by Size of Orchard

Maturity group	Typical varieties[a]	Usual range in harvest dates	Size of orchard (acres)				
			0–20	20–50	50–100	100–300	300–600
			per cent				
Extra early	Fortuna, Vivian, Dixon................	July 15—August 1	0	0	17	25	25
Early	Cortez, Paloro, Peak, Johnson..........	August 1–August 15	33	50	33	25	25
Late	Gaume, Sims, Halford, Carolyn........	August 15–September 1	66	50	33	25	25
Extra late	Wiser, Stuart, Gomez, Corona.........	September 1–September 20	0	0	17	25	25
			number				
Total number of varieties.................................			3	4	6	8	10
Number of age groups per variety[b].................................			1	2	2	2	2
Total number of blocks (number of varieties × number of age groups per variety).................................			3	8	12	16	20
Acres per block (at upper limit of size group).................................			6	6	8	19	30

[a] Varieties listed are merely representative of the commercial varieties available in each maturity group.
[b] For example, one block of Fortuna may be 6 years old; another block in the same orchard may be 12 years old.

Thus, large orchards will ordinarily have more varieties than small orchards. Based on these considerations, table 3 shows the spread of varieties assumed for each size of orchard in this study. For example, orchards of 0 to 20 acres have only three varieties—one in the early period and two in the late period. Orchards of 100 to 300 acres, however, have eight varieties with two in each maturity group. In addition, this acreage is sufficiently large to have two sizable blocks of different ages within each variety, making a total of 16 blocks of peaches. For all sizes of orchards the varieties are evenly staggered by age to avoid wide fluctuations in annual tonnage from pulling and replacing old blocks of trees. The varieties shown in each maturity group are merely representative of many commercial varieties available.

Table 4 shows the yield per acre by variety group for orchards of low, medium, and high production.[6] This wide range in observed yields may be attributable to differences in soils, irrigation practices, pruning, spraying, fertilization, and other management practices. The average length of tree life assumed is 20 years, although many orchards are currently replaced at an earlier age, particularly with the green-drop credit for pullouts. Again, considerable variation is observed from orchard to orchard and block to block.[7]

Labor and Buildings

Under present practices, labor costs are by far the most important preharvest and harvest cash costs in cling peach production. Wages used in this study are: $1.50 per hour for skilled labor (primarily for tractor and machine operation); $1.15 per hour for unskilled labor

for pruning, thinning, and other preharvest labor; and 17 cents per 40-pound lug ($8.50 per ton) for picking labor.[8] These rates are included in computing total costs even when a portion of the labor is furnished by the operator and family and does not, therefore, represent a direct cash outlay.

Based on 1959 farm survey information, the following specifications are also made: For operations of less than 100 acres, the operator provides his own management and supervision, does not maintain a labor camp and has $5,000 invested in buildings for machinery storage. For each additional 100 acres the owner adds one foreman at $6,000 per year plus an additional investment of $15,000 for foreman housing, labor camp, and machinery storage. For example, costs for operations ranging from 100 to 200 acres are based on one operator, one foreman, and $20,000 ($5,000 + $15,000) invested in buildings and housing; costs for operations ranging from 200 to 300 acres are based on one operator, two foremen and $35,000 ($20,000 + $15,000) invested in buildings and housing. The same wage rates and quality of labor are assumed for all farms, regardless of whether a labor camp is furnished. When camp facilities are furnished, deductions of $1.75 to $2.25 per man per day are assumed to equal food costs, gas, electricity, and upkeep and repair of the labor camp. Under these conditions, operators absorb the annual fixed costs of the labor camp (primarily depreciation and interest on the investment) to assure a more stable and convenient labor supply.

[6] See: Faris, J. E., *Economics of Replacing Cling Peach Trees*, Giannini Foundation Mimeographed Report No. 232, University of California, Berkeley, June, 1960, pp. 23–35.

[7] An earlier study by Faris, *ibid.*, pp. 71–77, provides the economic rationale underlying optimum tree replacement policy.

[8] Earlier varieties are usually picked twice. The rate of 17 cents per lug represents a weighted average of 75 per cent of the crop at 14 cents per box (first picking) and 25 per cent of the crop at 20–24 cents per box (second picking). It is assumed that later varieties are picked only once at 17 cents per lug. Wage rates are based on 1959 and 1960 *California Weekly Farm Labor Reports* for Butte, Sutter, and Yuba counties.

Table 4. Yield per Acre by Maturity Groups and Type of Orchard

Age of trees (years)	Early maturing varieties (extra early and early)			Late maturing varieties (late and extra late)		
	Low	Medium	High	Low	Medium	High
	tons per acre					
4	3.0	4.0	6.0	4.0	5.0	6.5
5	5.0	8.0	9.0	6.0	8.0	12.0
6	9.0	13.0	16.0	9.0	14.0	17.5
7	10.5	15.0	18.0	11.0	16.0	19.0
8	11.5	15.0	19.0	13.0	17.0	20.0
9	12.0	15.0	19.0	14.0	17.5	20.0
10	12.0	15.0	19.5	14.0	17.5	21.0
11	12.0	15.0	19.5	14.0	17.5	21.0
12	12.0	15.0	19.5	14.0	17.5	21.0
13	12.0	15.0	19.5	14.0	17.5	21.0
14	12.0	15.0	19.5	14.0	17.0	21.0
15	12.0	15.0	19.5	14.0	17.0	21.0
16	12.0	15.0	19.0	14.0	16.5	20.5
17	12.0	14.5	19.0	13.5	16.5	20.0
18	12.0	14.5	19.0	13.5	16.0	20.0
19	12.0	14.0	19.0	13.0	16.0	19.5
20	11.5	14.0	18.0	13.0	15.5	19.0
Total tonnage	182.5	232.0	298.0	208.0	262.0	320.0
Average yield per year (20 years)	9.1	11.6	14.9	10.4	13.1	16.0

DERIVATION OF A TYPICAL LONG RUN AVERAGE COST CURVE

To illustrate the procedures used in this study, a long run average cost curve is derived for a specified set of conditions in the Yuba City-Marysville area. Medium yields (see table 4) and no green drop are assumed. Wage rates and production practices are based on current conditions. In developing the cost curves it is convenient to divide costs into four major components: (1) preharvest variable costs, (2) harvest variable costs, (3) overhead or fixed costs, and (4) miscellaneous costs. These costs are explained more fully below.

Preharvest Variable Costs

Preharvest variable costs include all direct cash costs for the preharvest operations. These costs vary depending on the age of the orchard and the size and type of machinery and equipment. Table 5 illustrates the nature and magnitude of these annual costs for a mature orchard (12 to 20 years old) based on machinery size group III (table 2). Of course, preharvest variable costs differ somewhat for orchards of different ages operated with different sizes of machinery. While these refinements were included in the

Table 5. Preharvest Variable Costs for Mature Cling Peach Orchard (12 to 20 years old) for Machinery Size III, Yuba City-Marysville Area

Operation	Labor, tractors, and equipment	Hours per acre	Dollars per acre					
			Labor[a]	Tractor	Equipment	Supplies	Contracts	Total
Pruning, 100 trees/acre...	Labor at $1.15 per hour....	52.0	$59.80	....	....	....	....	$59.80
Brush disposal..........	One man, wheel tractor, wagon, and disk	2.0	3.00	$1.50	$0.66	....	....	5.16
Wiring...............	One man...........	1.0	1.50	....	....	$1.00	....	2.50
Spraying, dormant......	One man, tracklayer, spray rig.....	0.6	0.90	0.96	1.59	2.40	....	5.85
Spraying, pink bud.....	One man, tracklayer, spray rig.....	0.6	0.90	0.96	1.59	16.40	....	19.85
Cultivating cover crop..	One man, tracklayer, disk, and roller, 2 times	0.8	1.20	1.28	0.29	....	....	2.77
Fertilizing............	One man, fertilizer spreader, and wheel tractor	0.2	0.30	0.15	0.03	22.50	....	22.98
Thinning.............	Contract at $1.15 per hour........	100.0	115.00	....	....	....	....	115.00
Ridging up............	One man, wheel tractor, ridger, 2 times.....	1.0	1.50	0.75	0.30	....	....	2.55
Irrigating............	One man at $1.15 per hour, 5 times (pumping costs, $8 per acre, including standby)......	10.0	11.50	....	8.00	....	....	19.50
Disking weeds.........	One man, tracklayer, disk, and roller....	0.4	0.60	0.64	0.14	....	....	1.38
Knocking ridges down...	One man, wheel tractor, scraper, 2 times...	1.0	1.50	0.75	....	....	....	2.25
Propping.............	One man, wheel tractor, wagon.....	2.0	3.00	1.50	0.24	....	....	4.74
Dusting..............	Contract, 2 times............	....	....	....	....	11.60	$2.56	14.16
Constructing driveways..	One man, wheel tractor, scraper.....	0.2	0.30	0.15	....	....	....	0.45
Disking..............	One man, tracklayer, disk, 2 times...	0.8	1.20	1.28	0.17	....	....	2.65
Seeding cover crop.....	One man, wheel tractor, seeder, and harrow...	1.5	2.25	1.13	0.23	2.80	....	6.41
Spraying, fall.........	One man, tracklayer, spray rig......	0.6	0.90	0.96	1.59	9.20	....	12.65
Miscellaneous.........	Operating pickup truck, $8 per acre; social security and compensation insurance, 8 per cent of labor cost; $3 per acre for replanting and $5 per acre for telephone and office supplies......	....	18.43	0.50	8.50	5.00	....	32.43
Total		....	$223.78	$12.51	$23.33	$69.90	$2.56	$333.08

[a] Labor costs at $1.50 per hour unless otherwise specified.

analysis, the net result on preharvest costs is relatively minor. The cultural practices are based on recent California Extension Service cost analyses and previous research publications, and are supplemented with information from a 1959 survey of producers.[9] Costs for labor, materials, and other inputs have been updated and adjusted to the previously specified assumptions of the present study.

Harvest Variable Costs

Variable costs of harvesting include costs of picking and hauling to the receiving station. Basic handling methods used are those shown in a prior study by Stollsteimer[10] to be most efficient (least cost) for operations of different sizes. Table 6 summarizes harvest costs based on the Stollsteimer data relevant to the present study. Operations of approximately 50 acres and less (machinery groups I and II) employ 40-pound lugs which are hauled by farm trailers. Operations handling greater tonnages use pallet bins, forklifts, and trucks for maximum efficiency. Stollsteimer's study specifies the maximum output (lugs or tons) per hour which can be handled by each hauling method. The present study assumes that each variety has approximately a 5-day (50-hour) harvesting season. Thus, the capacity handling rate per hour together with the specified 50-hour harvesting season per variety determines the maximum tonnage of each variety which can be handled with given equipment. The pick-

ing cost of 17 cents per lug ($8.50 per ton) and 75 cents per ton for crew supervision are added to the hauling costs to determine total variable costs for harvesting.

Fixed Costs

Fixed or overhead costs are those which, in the short run, do not vary with output. Table 7 summarizes the annual fixed costs synthesized for peach orchards of different sizes. These include interest and taxes on the land investment, depreciation, interest, taxes, and insurance on machinery, buildings, and the irrigation system, plus the annual salary for the required number of foremen. The basis for these costs has been described above.

Miscellaneous Costs

Several significant costs are not specified in the above categories. One such cost is an assessment of $2.40 per ton paid by the producer to finance the advertising of cling peaches under the marketing order. Canners match this amount to provide a total advertising budget of $4.80 per ton. Another important cost is associated with bringing peach trees into bearing. Standard accounting procedure is to accumulate the costs incurred in the nonbearing years, then to spread this cost over the bearing life of the orchard. In this study, only the variable costs of pulling an old block of peaches, planting new trees, and bringing them up to bearing age (four years) are included as development costs.[11] Depreciation and interest on this accumulated development cost are charged over the bearing life of the orchard.

Short Run and Long Run Average Cost Curves

Using the theoretical framework and cost components outlined above, short

[9] See: Parsons, P. S., and Art Retan, "Suggested Costs in Raising Peaches in Butte County," University of California Agricultural Extension Service, March, 1960, pp. 1–2; Burlingame, B. B., Vernon Patterson, and Norman Ross, "Cling Peach Cost Studies in Stanislaus County, 1960," University of California Agricultural Extension Service, 1960, pp. 1–2; and Faris, J. E., *op. cit.*, pp. 36–56.

[10] See: Stollsteimer, John F., *Bulk Containers for Deciduous Fruits: Costs and Efficiency in Local Assembly Operations*, Giannini Foundation Research Report No. 237, University of California, Berkeley, December, 1960, p. 52.

[11] Fixed costs of land and machinery are not included in the accumulated development cost because they are charged as costs to the overall farming operation.

Table 6. Variable Costs of Harvesting (Picking and Hauling) Cling Peaches[a]

Machinery size group	Handling methods	Handling capacity			Crew and equipment					Hauling: variable cost per hour[b]			Hauling: variable	Picking: variable[c]	Picking plus hauling: variable[c]
		Capacity output rate		Maximum tons per variety (50 hrs)	Crew	Tractors	Trailers	Trucks	Forklifts	Labor	Equipment	Total			
		lugs/hour	tons/hour	tons	number of men		number			dollars per hour			cost per ton		
I	lugs— trailers	137	2.74	137	3	1 gas	3	0	0	$4.80	$0.95	$5.75	$2.10	$9.25	$11.35
II	lugs— trailers	254	5.08	254	3	2 gas	6	0	0	4.80	1.90	6.70	1.32	9.25	10.57
III	bins— trucks	251	5.02	251	2	1 diesel	0	2	1	3.20	3.95	7.15	1.42	9.25	10.67
IV	bins— trucks	502	10.04	502	4	2 diesel	0	3	2	6.40	6.30	12.70	1.26	9.25	10.51
V	bins— trucks	753	15.06	753	6	3 diesel	0	5	3	9.60	9.45	19.05	1.26	9.25	10.51

[a] Hauling costs based on: Stollsteimer, John F., *Bulk Containers for Deciduous Fruits: Costs and Efficiency in Local Assembly Operations*, Giannini Foundation Research Report No. 237, University of California, Berkeley, December, 1960, pp. 12–24. Hauling capacity and costs based on a one-way haul of 3 miles to the receiving station. Handling methods are described in detail in this publication.

[b] Based on: $1.60 per hour for labor ($1.50 + social security and compensation insurance); tractor operating costs of 95 cents per hour (gas) and 75 cents per hour (diesel); truck operating costs of $1.60 per hour. Hauling costs include loading in orchard and distribution of empty lugs or bins.

[c] Harvest costs include picking at 17 cents per lug ($8.50 per ton) plus supervision of picking crew at 75 cents per ton.

Table 7. Fixed Costs for Cling Peach Orchards

Machinery size group	Approximate acreage in orchard	Item[a]	Investment		Depreciation		Interest on investment		Taxes and insurance		Total annual fixed costs	
			Per acre	Total	Per acre	Total	Per acre	Total	Per acre	Total	Per acre	Total
All size groups	All size groups	Land............	$1,200	......	.....	......	$72.00	......	$15.00	......	$87.00	......
		Irrigating system .	150	......	$7.50	......	4.50	......	1.87	......	13.87	......
I	0–20	Buildings........	.....	$ 5,000	.....	$ 200	.....	$ 150	.....	$ 62.50	.....	$ 412.50
		Machinery (NM)..	.....	9,155	.....	1,127	.....	276	.....	113.00	.....	1,516.00
		Machinery (M)....	.....	23,755	.....	3,091	.....	714	.....	295.00	.....	4,100.00
II	20–50	Buildings........	.....	5,000	.....	200	.....	150	.....	62.50	.....	412.50
		Machinery (NM)..	.....	26,555	.....	2,510	.....	828	.....	343.00	.....	3,681.00
		Machinery (M)....	.....	41,155	.....	4,474	.....	1,266	.....	525.00	.....	6,265.00
III	50–100	Buildings........	.....	5,000	.....	200	.....	150	.....	62.50	.....	412.50
		Machinery (NM)..	.....	46,370	.....	4,355	.....	1,392	.....	573.00	.....	6,320.00
		Machinery (M)....	.....	59,370	.....	6,212	.....	1,782	.....	735.00	.....	8,729.00
IV	100–200	Buildings........	.....	20,000	.....	800	.....	600	.....	250.00	.....	1,650.00
		Foreman labor....	.....	6,000	.....	.....	.....	.....	.....	.....	.....	6,000.00
		Machinery (NM)..	.....	73,920	.....	6,708	.....	2,219	.....	917.00	.....	9,844.00
		Machinery (M)....	.....	99,920	.....	10,422	.....	2,999	.....	1,241.00	.....	14,662.00
	200–300	Buildings........	.....	35,000	.....	1,400	.....	1,050	.....	438.00	.....	2,888.00
		Foreman labor....	.....	12,000	.....	.....	.....	.....	.....	.....	.....	12,000.00
		Machinery (NM)..	.....	73,920	.....	6,708	.....	2,219	.....	917.00	.....	9,844.00
		Machinery (M)....	.....	112,920	.....	12,279	.....	3,389	.....	1,403.00	.....	17,071.00
V	300–400	Buildings........	.....	50,000	.....	2,000	.....	1,500	.....	625.00	.....	4,125.00
		Foreman labor....	.....	18,000	.....	.....	.....	.....	.....	.....	.....	18,000.00
		Machinery (NM)..	.....	110,705	.....	10,334	.....	3,323	.....	1,373.00	.....	15,030.00
		Machinery (M)....	.....	149,705	.....	15,905	.....	4,493	.....	1,859.00	.....	22,257.00
	400–500	Buildings........	.....	65,000	.....	2,600	.....	1,950	.....	812.00	.....	5,362.00
		Foreman labor....	.....	24,000	.....	.....	.....	.....	.....	.....	.....	24,000.00
		Machinery (NM)..	.....	110,705	.....	10,334	.....	3,322	.....	1,373.00	.....	15,030.00
		Machinery (M)....	.....	162,705	.....	17,762	.....	4,883	.....	2,021.00	.....	24,666.00

[a] Symbol NM refers to machinery required when pruning, thinning, and harvesting are nonmechanized; symbol M refers to machinery required when these operations are mechanized to the extent described in the report.

and long run average cost curves are derived for conditions of *medium yields* with *no green drop*. Table 8 summarizes the total costs and cost per ton of achieving various output rates for each of the five machinery size groups; figure 2 depicts the results graphically. Each short run average cost curve is extended to the maximum tonnage which can be handled by the hauling equipment at harvest time. The long run average cost curve is drawn as an envelope to the short run curves. Figure 2 shows that costs per ton drop steadily until output reaches approximately 715 tons (58 acres), and remain essentially constant thereafter. Table 8 indicates clearly the reasons for the shapes of the short run and long run average cost curves of figure 2. For each short run curve the annual costs of buildings, machinery, and foreman labor are fixed; other costs are proportionate to acreage or tonnage. Therefore, increased output in each short run case spreads the fixed or overhead costs over more units of output and reduces costs per ton. The long run average costs per ton (envelope curve) drops to about 715 tons (approximately 60 acres) because of less than proportionate increases in investment in machinery and buildings between machinery groups I and II, accompanied

Fig. 2. Average cost curves for cling peach orchards (Yuba City, medium yields, no green drop)
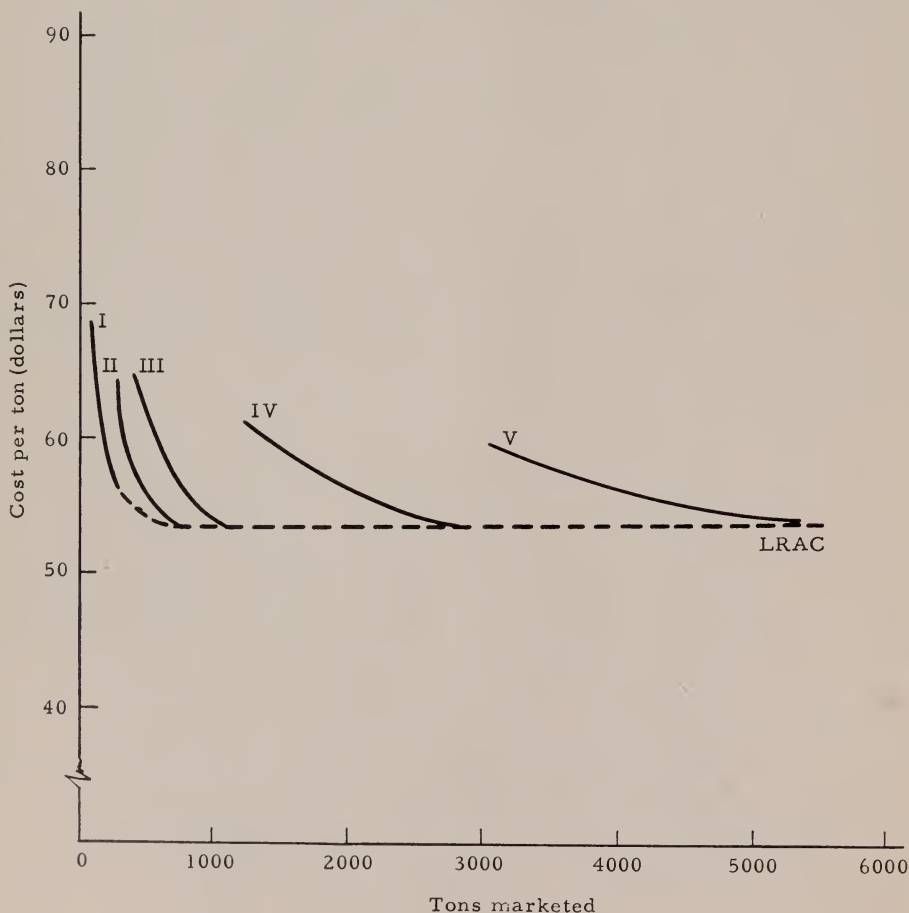
16

Table 8. Budgeted Costs for Different Sizes of Nonmechanized Cling Peach Orchards (Medium Yield Level, No Green Drop)[a]

Machinery component	Total acres (bearing + non-bearing)[b]	Tons produced (12.35 tons/acre)	Costs fixed per machinery group		Costs dependent on total acreage			Costs dependent on tonnage		Total cost	Cost per ton
			Buildings and machinery[e]	Foreman labor[d]	Land and irrigation systems[c]	Preharvest variable costs[e]	Cost of trees[f]	Harvest variable costs[g]	Marketing order[h]		
I	.....	.....	.....	.....	($100.87/acre)	($290.85/acre)	($47.00/acre)	($11.35/ton)	($2.40/ton)	.....	.....
	8	99	$1,928.50	0	806.96	2,326.80	376.00	1,123.65	237.60	$ 6,799.51	$68.68
	15	185	1,928.50	0	1,513.05	4,362.75	705.00	2,099.75	444.00	11,053.05	59.75
	24	296	1,928.50	0	2,490.88	6,980.40	1,128.00	3,359.60	710.40	16,527.78	55.84
II	.....	.....	.....	.....	($100.87/acre)	($279.85/acre)	($47.00/acre)	($10.57/ton)	($2.40/ton)	.....	.....
	20	247	4,093.50	0	2,017.40	5,597.00	940.00	2,610.79	592.80	15,851.49	64.18
	40	494	4,093.50	0	4,034.80	11,194.00	1,880.00	5,221.58	1,185.60	27,609.48	55.89
	58	716	4,093.50	0	5,850.46	16,231.30	2,726.00	7,568.12	1,718.40	38,187.78	53.33
III	.....	.....	.....	.....	($100.87/acre)	($276.85/acre)	($47.00/acre)	($10.67/ton)	($2.40/ton)	.....	.....
	50	618	6,732.50	0	5,043.50	13,842.50	2,350.00	6,594.06	1,483.20	36,045.76	58.33
	70	864	6,732.50	0	7,060.90	19,379.50	3,290.00	9,218.88	2,073.60	47,755.38	55.27
	86	1,062	6,732.50	0	8,674.82	23,809.10	4,042.00	11,331.54	2,548.80	57,138.76	53.80
IV	.....	.....	.....	.....	($100.87/acre)	($276.85/acre)	($47.00/acre)	($10.51/ton)	($2.40/ton)	.....	.....
	100	1,235	11,494.00	$6,000.00	10,087.00	27,685.00	4,700.00	12,979.85	2,964.00	75,909.85	61.46
	175	2,161	11,494.00	6,000.00	17,652.25	48,448.75	8,225.00	22,712.11	5,186.40	119,718.51	55.40
	229	2,828	11,494.00	6,000.00	23,099.23	63,398.65	10,763.00	29,722.28	6,787.20	151,264.36	53.49
V	.....	.....	.....	.....	($100.87/acre)	($276.85/acre)	($47.00/acre)	($10.51/ton)	($2.40/ton)	.....	.....
	250	3,088	19,155.00	18,000.00	25,217.50	69,212.50	11,750.00	32,454.88	7,411.20	183,201.08	59.33
	350	4,322	19,155.00	18,000.00	35,304.50	96,897.50	16,450.00	45,424.22	10,372.80	241,604.02	55.90
	430	5,310	19,155.00	18,000.00	43,374.10	119,045.50	20,210.00	55,808.10	12,744.00	288,336.70	54.30

a Pruning, thinning and harvesting by hand.
b Each size group expanded to maximum acreage permitted by machinery capacity.
c See table 7.
d See discussion in text under "Labor and Buildings."
e See table 5 for operations and preharvest costs on a mature orchard. Costs here based on average over life of orchard; includes $6.85 per acre annual fixed cost on

$67.00 investment in miscellaneous equipment per acre (table 2) and $13.00 per acre interest at 7½ per cent for 6 months on production capital.
f Includes depreciation and interest on investment in bringing trees into bearing.
g See table 6.
h Assessment against grower, matched by canner, to pay for advertising.

by reductions in preharvest and harvest variable costs. Beyond about 60 acres, long run costs per ton are essentially constant. Shifts between size groups III, IV, and V show that the advantages of slight reductions in harvesting costs and machinery investment per acre are offset by increases in costs of supervision (foreman labor).

Thus, under present production practices and resource organization of cling peach farms in the Yuba City-Marysville area, the unit cost economies of large-scale production are achieved by farms of about 60 acres. As pointed out earlier, the great bulk of peach farms in the area are much smaller than 60 acres, and are, therefore, operating at higher costs per ton than those possible for larger farms.

It is emphasized that the long run cost curve of figure 2 estimates the *least cost* of achieving each level of output, assuming *medium* level yields (see table 4) and *no green drop*. Actual conditions on individual farms and in particular years vary widely from this basic situation. The effects of varying the more critical factors are summarized in the subsequent analysis.

Comparison of Yuba City-Marysville Area with Modesto Area

A general comparison of the two major peach producing districts indicates that conditions are sufficiently similar to suggest the same general conclusions with respect to economies of scale in both areas. Yields per acre in the two areas are quite comparable. Over the eight-year period 1952 to 1959 the average yields have been 13.3 tons per acre in the Yuba City-Marysville area and 12.8 tons per acre in the Modesto area.[12] Production practices, machinery combinations and land prices are similar in the two areas. Wage and tax rates in the Modesto area appear to have been slightly higher in recent years. However, irrigation costs are lower in Modesto than in the Marysville area.[13] The net effect of these differences in location is slight. Undoubtedly, the variation in yield level from ranch to ranch in the same area is a much more important factor in determining costs per ton than the variation in costs and practices between areas. Hence, while the remainder of the analysis is based on Yuba City-Marysville conditions, the general conclusions can be extended to the Modesto area with minor modifications.

EFFECTS OF YIELD LEVEL AND GREEN DROP ON COSTS AND PROFIT

The yielding ability of the orchard and the green drop provision of the cling peach marketing order are two major factors influencing the level of costs per ton harvested. Figure 3 indicates the magnitude of changes in costs per ton at low, medium and high yields, both with no green drop and with a 15 per cent green drop (the approximate percentage green drop in recent years). For reasons of space and clarity of presentation, only the long run average cost curves are shown in figure 3 and throughout the rest of the report; as indicated before, these represent envelopes of the short run curves.

As expected, figure 3 shows that the

[12] Based on data from Cling Peach Advisory Board, *Orchard and Production Survey, 1959–60*, and earlier years.

[13] See: Parsons and Retan, *op. cit.*, pp. 1–2, and Burlingame, *et al.*, *op. cit.*, pp. 1–2.
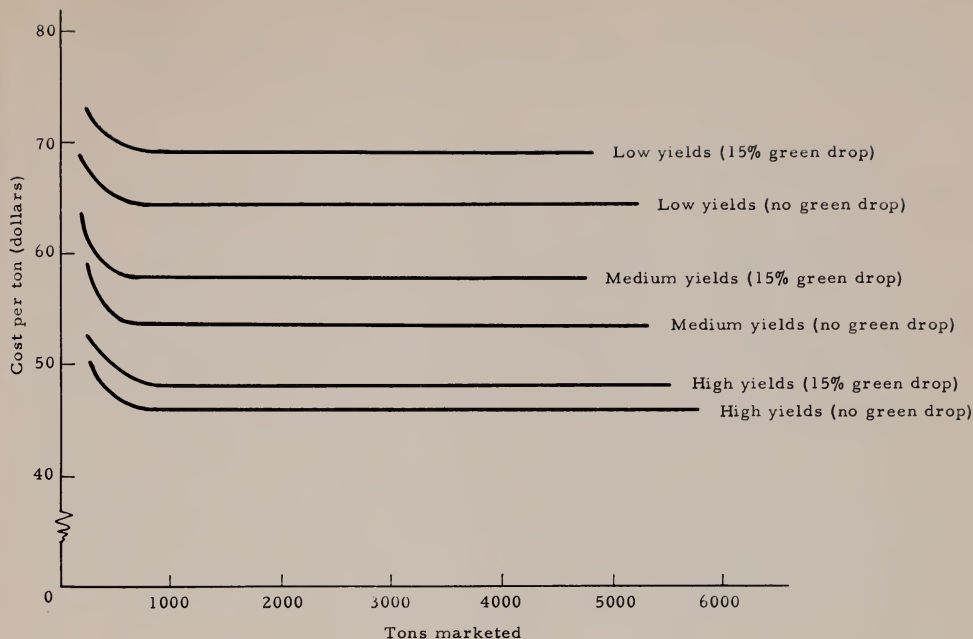
Fig. 3. Long run average cost curves for different yield levels, with 15 per cent green drop and with no green drop (Yuba City)

15 per cent green drop provision increases costs per ton substantially for any given yield level. However, level of yield per acre is a more important factor affecting costs per ton. For example, with a 15 per cent green drop, there is a $21 difference in costs per ton between orchards with low versus high yields.

If cling peach prices are about $58 per ton with a 15 per cent green drop, figure 3 indicates that even an efficiently operated ranch of over 60 acres must attain yields higher than the *medium* level (for yield assumptions, see earlier table 4) in order to show profits. It is emphasized again that the cost curves of figure 3 and throughout the report include not only cash costs and depreciation, but in addition a market rate of return on the entire capital investment and prevailing wages for any labor performed by the operator and family. However, no management charge for the operator is included. In other words, not all high-cost farms are

threatened with bankruptcy, even when costs per ton so computed exceed price. A farmer owning his orchard and equipment need not receive a market rate of return on his investment or his labor in order to stay in business. So long as returns cover cash costs plus depreciation, this farmer can stay in business indefinitely provided he is willing to accept below-market returns for his resources.

The difference between costs per ton shown in figure 3 and price can be defined as profit or returns to management. Using this definition, table 9 indicates the level of profits for cling peach orchards of different sizes and yield levels. A 15 per cent green drop is assumed and profits are shown for four alternative cling peach prices per ton: $68, $62, $58 (approximately the recent level excluding the 1961 season), and $54 per ton. The data in table 9 suggest that yield level is fully as important as scale of operation in determining profits. Cling peach or-

Table 9. Total Farm Profit for Cling Peach Operations of Different Sizes and Yields, with Peach Prices at Four Alternative Levels (assumes 15 per cent green drop)[a]

Yield level	Peach price per ton	Profit for operations of various sizes				
		10 acres	20 acres	50 acres	100 acres	300 acres
Low...............	$54	$-2,000	$-3,400	$-7,400	$-13,500	$-40,500
	58	-1,700	-2,700	-5,600	-9,900	-29,700
	62	-1,300	-2,100	-3,800	-6,300	-18,900
	(68)	- 800	-1,100	-1,100	- 900	- 2,700
Medium............	54	-1,300	-1,900	-2,200	-4,400	-13,300
	58	- 800	-1,000	0	0	0
	62	- 400	- 200	2,200	4,400	13,300
	68	200	1,000	5,600	11,100	33,300
High...............	54	- 100	300	4,300	8,600	25,700
	58	400	1,300	7,200	14,300	42,900
	62	900	2,400	10,000	20,000	60,000
	68	1,700	4,000	14,300	28,600	85,800

[a] Total farm profit is defined as the residual after all costs (including a market rate of return on capital investment) are subtracted from gross income.

chards with *low* yields show losses for the entire range of peach prices and sizes of operation considered. On the other hand, orchards of only 10 to 20 acres show profits with *high* yields. However, even with high yields and a continuation of peach prices at about $58 per ton, an operation of 50 acres or more is required to provide reasonable profits. At recent prices, few farms in the Yuba City-Marysville area have been able to combine high yields, large-scale operation, and efficient production methods to attain positive profits as computed in this report.

While the individual cost curves shown in figure 3 do not indicate further economies of scale beyond about 60 acres, there are at least two advantages of large-scale operations not readily apparent. First, the variability of yields from year to year tends to be reduced on larger farms because of the larger number of blocks of peaches, allowing greater diversification through time within the year. In addition, having many blocks of trees with staggered ages reduces the impact on total production of pulling and replacing a block of trees. For example,

on orchards of less than 20 acres with only three blocks, the coefficient of variation in total farm production from year to year is 15.4 per cent.[14] For farms having eight blocks evenly staggered (about 50 acres in this study), the coefficient of variation is reduced to 3.8 per cent. As the number of blocks is increased successively to 12, 16, and 20, the coefficient of variation is reduced to 2.3 per cent, 1.7 per cent, and 0.6 per cent, respectively. Thus, on large farms, pulling and planting peaches is almost an annual operation, and variation in total production from this source is essentially eliminated.

A second advantage of larger operations is their greater ability to take advantage of the provisions of the green-drop program. Under provisions of this program, pulling peach trees can be substituted for green-drop tonnage. Thus,

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[14] Coefficient of variation = standard deviation of total production ÷ average annual production. This variation is based only on changes in total production due to pulling and planting blocks of peaches. Of course, weather variations and production practices are sources of additional variability.

larger operators who pull a small percentage of their total acreage each year can apply the entire acreage toward their green-drop requirement. A smaller producer who pulls a large percentage at infrequent intervals loses this advantage.

EFFECTS OF WAGE RATES ON COSTS

Many cling peach growers are concerned about the effect on costs of possible increases in wage rates. This concern is well placed, since approximately 45 to 50 per cent of the present costs per ton are attributable to labor. Figure 4 illustrates the effect of wage increases (including foreman wages) up to 50 per cent on operations with medium and high yields. A wage increase of 50 per cent would increase costs by $13 per ton for medium-yielding orchards and by $12 per ton for high-yielding orchards. On medium-yielding orchards over 60 acres, any increase in wages would result in losses at a continuation of a $58 per ton price for peaches.[15] However, high-yielding orchards of efficient size could continue to make profits until wages increased up to about 40 per cent. Again, the importance of high yields per acre is apparent.

[15] Losses or profits on operations of various sizes can be computed directly from the graphs by finding the difference between cost and assumed price per ton, then multiplying this difference by tonnage produced.

Fig. 4. Effect of increases in the wage rate on cost curves for cling peach orchards (Yuba City, 15 per cent green drop)
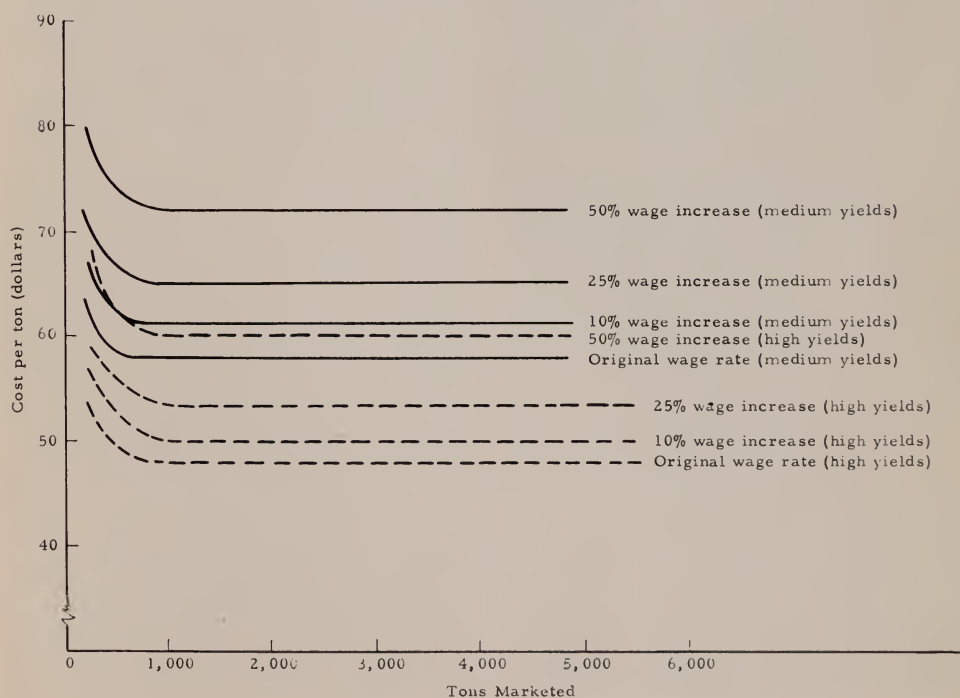
The possibility that wages will increase and labor supplies become unreliable in the future has greatly increased the interest in mechanization of peach production. The three basic operations requiring large labor inputs are pruning, thinning, and harvesting. Several alternative machines and methods have been developed to reduce labor in these operations. Several of the methods have been tested to some extent in the field; others are still in the experimental stage. It is probable that the peach industry would swing rapidly from hand to mechanical operations if the latter proved economically feasible.

A specified set of mechanical pruning, thinning, and harvesting methods is presently showing considerable promise. Since the mechanical methods have been tested only briefly, an evaluation of them rests on a number of rather uncertain variables. These assumptions will be clearly specified to allow more accurate appraisal of the cost comparisons shown. Several questions will be considered: What are the comparative costs per ton for hand and mechanical methods? What is the minimum orchard size required to justify investing in mechanical equipment? What is the economic size of orchard under mechanization? What percentage loss from mechanical handling can be suffered before hand methods provide higher returns? How do hand and mechanical methods compare under higher wage rates?

Cost Data on Mechanization

The basic equipment required to shift to the mechanized operation has been summarized previously at the bottom of table 2. A mechanical harvesting unit includes two shakers and two catching frames (shakers mounted on power-driven frames). An additional tricycle frame is required to mount the same shakers for mechanical thinning. At an estimated original cost of $13,000 and a seven-year life,[16] the annual fixed cost of this mechanical unit (including depreciation, interest on the investment, and taxes and insurance) is $2,409. The hourly variable costs of picking with this method are $7.90, broken down as follows: Repairs = $1.00; fuel = $0.50; 4 skilled men (2 driving frames and 2 on shakers) at $1.60 per hour = $6.40. It is assumed that the early and extra early varieties are picked twice. The mechanical harvesting unit is used on the first pick (75 per cent of the crop), followed by a second hand pick at 24 cents per box or $12.00 per ton. Late and extra late varieties are picked only once, using the mechanical harvester. However, two extra unskilled laborers (at $1.25 per hour each) using hand poles are required for the one-pick operations. The machine is estimated to pick 30 trees per hour (.3 acres per hour). Thus, the total variable cost of the two-pick operation is $26.33 per acre, plus 24 cents per box for hand-picking the 25 per cent of the crop on the second picking. Total variable costs of the one-pick operation are $34.66 per acre.

As mentioned earlier, a 50-hour harvesting season per variety is assumed. Thus, at .3 acres per hour, the capacity of a harvester is approximately 15 acres per variety. Obviously, the producer with a large number of variety blocks can use the harvester most advantageously. For example, the large producer with ten varieties spaced through the season can handle up to 150 acres with one harvesting unit. Bulk handling methods are required to make efficient use of the mechanical harvesting equipment. Larger

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[16] The machine is unlikely to wear out for at least ten years. On the other hand, a newly developed machine such as this may be obsolete in less than five years. The seven-year rate was chosen on the basis that farmers would probably adapt or revise their present machine as new developments were forthcoming.
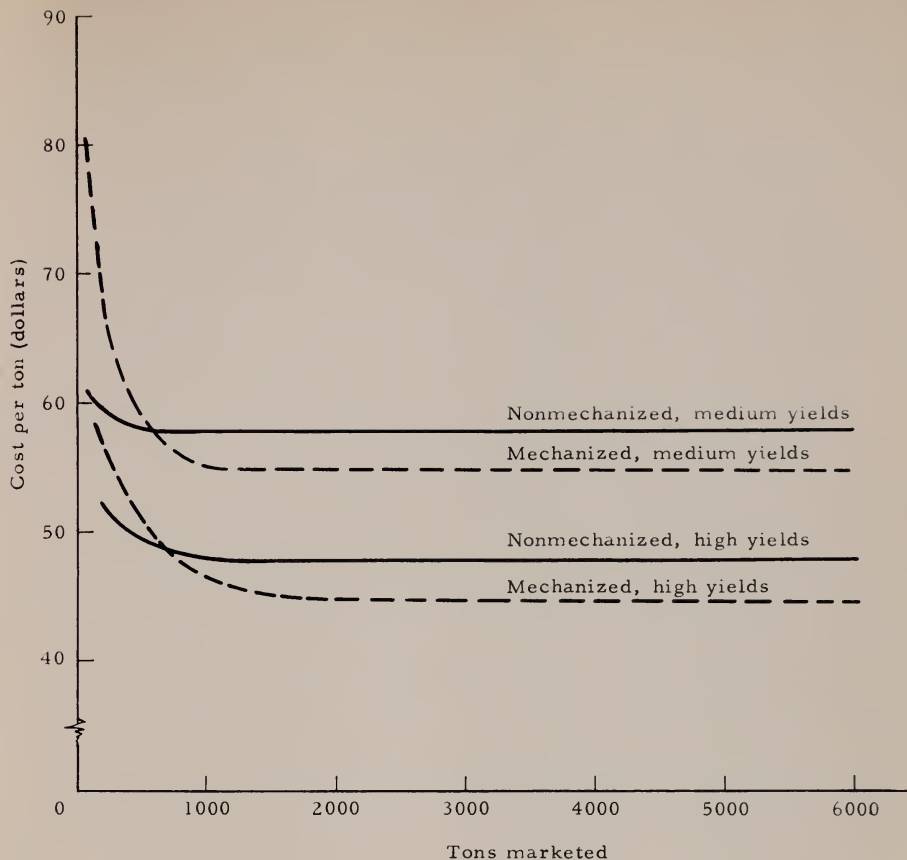
Fig. 5. Comparison of cost curves for mechanized and nonmechanized cling peach orchards (Yuba City, 15 per cent green drop, 10 per cent loss from mechanical harvesting)

crease in wages would reduce the break-even point for medium and high yields to about 30 and 25 acres, respectively. A 50 per cent wage increase would further reduce the respective break-even points to about 20 and 18 acres.

The extent of mechanical damage from harvesting is still somewhat uncertain. It would be desirable, therefore, to know the maximum allowable amount of mechanical damage which can be incurred before mechanization loses its cost and profit advantage. Table 11 presents these maximum allowable losses under a variety of conditions. Several conclusions can be drawn:

1. The percentage of allowable loss in-creases materially with increased farm size, stemming from substantial economies of scale under mechanization. For example, with peach prices at $58 per ton, wages at the original rate and high yield levels, the amount of allowable loss increases from 0 per cent for 20 acres to 13 per cent for orchards of 100 acres and over.

2. When wage rates increase, the percentage of allowable loss from mechanization is increased considerably. Thus, increases in wages would greatly increase the profitability and thereby the probability of mechanization in the peach industry. For example, an operator of a 40-acre orchard with medium yields and

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Table 11. Percentage Loss in Mechanical Harvesting Damage Allowable to Make Net Returns Equal from Mechanized and Nonmechanized Peach Operations[a]

Acreage and yield level	Harvesting damage allowable											
	Peach price = $50 per ton			Peach price = $54 per ton			Peach price = $58 per ton			Peach price = $62 per ton		
	Original wage rate[b]	25 per cent increase in wages	50 per cent increase in wages	Original wage rate[b]	25 per cent increase in wages	50 per cent increase in wages	Original wage rate[b]	25 per cent increase in wages	50 per cent increase in wages	Original wage rate[b]	25 per cent increase in wages	50 per cent increase in wages
Medium yields												
20 acres.............	..[c]	3%	9%	..[c]	3%	9%	..[c]	2%	8%	..[c]	2%	7%
40 acres.............	6%	14	20	6%	13	18	5%	12	17	5%	11	16
60 acres.............	11	17	23	12	16	22	10	15	20	9	14	19
Over 100 acres........	17	24	31	16	22	29	15	21	27	14	19	25
High yields												
20 acres.............	0	5	10	0	4	9	0	4	9	0	4	8
40 acres.............	8	14	19	8	12	17	7	12	16	6	11	15
60 acres.............	11	16	22	10	15	20	10	14	18	9	13	17
Over 100 acres........	15	21	27	14	20	25	13	18	24	12	17	22

a Method of computation shown in Appendix B.
b $1.50 per hour for skilled labor; $1.15 per hour for unskilled labor.
c Net returns from mechanized operation lower than for nonmechanized operation, even with no loss from mechanical harvesting damage.

orchards are assumed to employ bulk handling, requiring no additional investment. However, orchards in the 0 to 50-acre range would require investment in additional forklifts (table 2).

Hand thinning is assumed for the first five years. In years 6 through 8, trees are mechanically thinned using the shakers mounted on the tricycle frame. The shaker operates at a variable cost of 15 cents per tree, plus 35 cents per tree for later hand thinning. In years 9 through 20, follow-up hand thinning costs are increased to 50 cents per tree. It is expected that the shaker will remove about three quarters of the total fruit to be removed in thinning. The follow-up hand thinning should be delayed approximately 2 weeks to make sure all fruit damaged by the mechanical thinning is apparent—otherwise, overthinning may occur. It should be mentioned that the mechanical shaking equipment is also used for the green-drop acreage.

Hand pruning is assumed during the first seven years when the trees are being trained. Mechanical pruning in the succeeding years (8 to 20) is hired entirely on a contract basis. A number of custom operators were already topping trees in 1960 and 1961 in the Yuba City and Modesto areas, at a prevailing custom rate of about 17 cents per tree. Additional hand pruning of 15 cents per tree completes the pruning costs. Some operators have developed topping machines to use for lighter pruning which may cut costs even below the custom rates.

Cost Comparisons Between Hand and Mechanical Methods

Table 10 shows the detailed calculations in arriving at costs per ton under mechanization, assuming no loss from mechanical damage in harvesting or reduction in tonnage from mechanical pruning and thinning and a 15 per cent green drop. The mechanical pruning and thinning methods described should, when employed properly, result in no reduction

in tonnage compared with hand methods. However, some physical damage in mechanical harvesting is inevitable since a portion of the fruit is cut, scratched or bruised as it drops through limbs or hits unpadded portions of the catching frame. The estimated damage varies widely with the number of branches per tree and type of equipment. University of California field tests conducted in 1960 indicate that hand-picked blocks had 8 to 10 per cent more good and minor-damaged fruit than machine-harvested blocks.[17]

Figure 5 compares the long run cost curves for nonmechanized (current practices) and mechanized cling peach production under medium and high yield levels. The mechanized curves are based on a damage loss of 10 per cent from mechanical harvesting. Several points relating to mechanization versus present practices should be stressed:

1. Under mechanization, costs per ton decrease with increased orchard size up to about 90 to 110 acres, then are nearly constant. With nonmechanization (current practices), this point is reached at only about 60 acres. Thus, mechanization would substantially increase the size of orchard required for efficient operation.

2. Mechanization results in higher costs per ton than nonmechanization for small farms and lower costs per ton for large farms. The break-even point (equal costs per ton for mechanization versus non-mechanization) is about 595 tons (approximately 55 acres). Of course, the likely development of mechanical harvesting and thinning on a contract basis could lower the costs per ton under mechanization for smaller operators.

3. The above results are based on present wages. An increase in wages would increase the relative advantage of mechanization. For example, a 25 per cent in-

[17] See: Fridley, R. B., P. A. Adrian, L. L. Claypool, S. J. Leonard, and M. O'Brien, *Mechanical Harvesting of Cling Peaches—1960*, University of California, Research Progress Report. Unpublished report. pp. 8–9.

Table 10. Budgeted Costs for Different Sizes of Mechanized Cling Peach Orchards (Medium-Yield Level, 15 Per Cent Green Drop, No Damaged Fruit Loss Assumed)[a]

Machinery component	Total acres (bearing + non-bearing)[b]	Tons produced (12.35 tons/acre)[b]	Costs fixed per machinery group			Costs dependent on total acreage		Cost of trees[e]	Costs dependent on tonnage		Total cost	Cost per ton
			Buildings[c]	Machinery[e]	Foreman labor	Land and irrigation systems[e]	Preharvest variable costs[d]		Harvest variable costs[f]	Marketing orders[g]		
I	...	...	...	...	...	($100.87/acre)	($227.85/acre)	($47.00/acre)	($6.65/ton)	($2.40/ton)	...	...
	8	84	$ 412.00	$ 4,100	0	807.00	1,823.00	376.00	559.00	202.00	$ 8,279	$98.56
	15	158	412.00	4,100	0	1,513.00	3,418.00	705.00	1,051.00	379.00	11,578	73.28
	24	252	412.00	4,100	0	2,421.00	5,468.00	1,128.00	1,676.00	605.00	15,810	62.74
II	...	...	...	...	...	(100.87/acre)	(216.85/acre)	(47.00/acre)	(6.19/ton)	(2.40/ton)	...	...
	20	222	412.00	6,265	0	2,017.00	4,337.00	940.00	1,374.00	533.00	15,878	71.52
	40	444	412.00	6,265	0	4,035.00	8,674.00	1,880.00	2,748.00	1,066.00	25,080	56.49
	58	643	412.00	6,265	0	5,850.00	12,577.00	2,726.00	3,980.00	1,543.00	33,353	51.87
III	...	...	...	...	...	(100.87/acre)	(213.85/acre)	(47.00/acre)	(5.77/ton)	(2.40/ton)	...	...
	50	556	412.00	8,729	0	5,044.00	10,692.00	2,350.00	3,208.00	1,334.00	31,769	57.14
	70	779	412.00	8,729	0	7,061.00	14,970.00	3,290.00	4,495.00	1,870.00	40,827	52.41
	86	957	412.00	8,729	0	8,675.00	18,391.00	4,042.00	5,522.00	2,297.00	48,068	50.23
IV	...	...	...	...	...	(100.87/acre)	(213.85/acre)	(47.00/acre)	(5.61/ton)	(2.40/ton)	...	...
	100	1,113	1,650.00	14,662	6,000	10,087.00	21,385.00	4,700.00	6,244.00	267.00	67,399	60.56
	175	1,948	1,650.00	14,662	6,000	17,652.00	37,424.00	8,225.00	10,928.00	4,675.00	101,216	51.96
	229	2,549	1,650.00	14,662	6,000	23,099.00	48,972.00	10,763.00	14,300.00	6,118.00	125,564	49.26
V	...	...	...	...	...	(100.87/acre)	(213.85/acre)	(47.00/acre)	(5.61/ton)	(2.40/ton)	...	...
	250	2,782	4,125.00	22,257	18,000	25,218.00	53,462.00	11,750.00	15,607.00	6,677.00	157,096	56.47
	350	3,896	4,125.00	22,257	18,000	35,304.00	74,848.00	16,460.00	21,856.00	9,350.00	202,190	51.90
	430	4,786	4,125.00	22,257	18,000	43,374.00	91,956.00	20,210.00	26,849.00	11,486.00	238,257	49.78

a "Mechanized" refers to mechanical pruning, thinning and harvesting. Final costs per ton should be increased by the per cent mechanical damage anticipated. Analysis assumes no loss in tonnage from mechanical pruning and thinning.

b Each size group expanded to maximum acreage permitted by machinery capacity.

c See table 7.

d Includes $6.85 per acre annual fixed cost on $67.00 investment in miscellaneous equipment per acre (table 2) and $13.00 per acre interest at 7½ per cent for 6 months on production capital.

e Includes depreciation and interest on investment in bringing trees into bearing.

f Summarized in text under "Cost Data on Mechanization."

g Assessment against grower, matched by canner, to pay for advertising.

a $58 price for peaches could afford to lose no more than 5 per cent in mechanical damage under present wages. However, if wages increased by 25 per cent and then by 50 per cent, the operator could afford losses from mechanical damage up to 12 per cent and 17 per cent, respectively.

3. The price of peaches has only a minor effect on the amount of mechanical damage permissible. Thus, while higher peach prices reduce the amount of permissible loss from mechanical damage, the effect is slight.

4. The level of yields also has little effect on the percentage of permissible loss.

It should be emphasized that the permissible losses of table 11 are not based solely on a comparison of hand and mechanical *harvesting* methods. Rather, the comparison is between operations employing conventional cultural practices (hand pruning, thinning, and picking) and those highly mechanized for *pruning, thinning,* and *harvesting.* A comparison of cost advantages and permissible losses from hand versus mechanical harvesting alone has been well presented by Fridley and Adrian.[18]

EVALUATION OF METHODS OF IMPROVING
THE ECONOMIC POSITION OF PEACH GROWERS

The cling peach industry has been characterized recently by relatively low incomes and considerable year-to-year variability in income. Several related questions are examined below: Can off-farm employment be combined with a small orchard operation to improve the economic position of the operator? Under what conditions would the operator be better off financially to sell out and work elsewhere? Does diversification offer a way of "leveling out" year-to-year income fluctuations?

Alternatives Involving
Off-Farm Employment

The possibility of supplementing farm income with off-farm employment is of interest primarily to the small grower who is underemployed on the ranch. Suppose the typical small grower took a full-time 40-hour per week job off the farm. He would continue to contract for thinning, harvesting, spraying, and dusting. In addition, however, he would probably have to hire some pruning—a job formerly done primarily by himself. He could probably arrange to take his vacation during harvest to supervise that operation. Under these circumstances, the peak requirement for operator labor is 4.4 hours per acre in June (see table 12). Assuming that the operator is willing to work weekends and some evenings during the week on the ranch, he could probably work 20 to 22 hours per week (88 hours per month) on the ranch in this rush period; other times of the year would demand fewer hours. This arrangement would allow an operator to work off-farm full time and still continue to farm up to about 20 acres in his spare time. The only additional cost of taking the full-time job would be his commuting costs and additional hired labor for pruning. Thus, the income from an off-farm job at, for example, $2 per hour could add nearly $4,000 to the net income of

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[18] Fridley, R. W., and P. A. Adrian, "Mechanical Harvesting Costs," *Western Fruit Grower,* No. 6, June, 1961, pp. 18–20.

Table 12. Estimated Hours Per Acre Labor Requirements for Cling Peaches

Operation	Hours required per acre											
	January	February	March	April	May	June	July	August	September	October	November	December
Disk										.4		
Plant cover crop										1.1		
Harrow										.4		
Spray, fall											.....	.6[a]
Prune	17.3[a]	17.3[a]									.....	17.3[a]
Brush disposal	.7	.7									.....	.7
Replant	1.0											
Fertilize	.2											
Wire	1.0											
Spray, dormant	.3[a]	.3[a]										
Spray, pink bud			.6[a]									
Cultivate cover crop												
Thin				.8 [	─── a ───	]						
Ridge				.5	.5	.5						
Knock ridges								.5				
Irrigate					2.5	2.5	2.5	2.5				
Disk weeds						.4		.4				
Prop						1.0	1.0					
Dust							.1	.1				
Scrape driveways												
Harvest and haul						[	─── a ───		]			
Total noncontract labor per acre	2.9	.7		1.3	3.0	4.4	3.6	3.5		1.9		.7

[a] Operation contracted.

the small (size I) grower. This analysis assumes that the quality and efficiency of pruning, thinning and harvesting are not impaired when the operator takes an off-farm job.

A grower with a year-around *half-time* job could handle nearly 40 acres of cling peaches using the same arrangement outlined above. In this size of operation (size II) the operator would also do his own spraying. Again, the off-farm earnings would be essentially a net addition to income, the exact amount depending on the off-farm wages obtained.

In summary, if integrated effectively with the farm operation, off-farm work can be an important supplement to the incomes of small growers. A number of the small operators visited in the 1959 survey did some off-farm work. Some were working in regular jobs in the Yuba City-Marysville urban area, while others worked seasonally at odd jobs. Many were gaining fuller utilization of labor and equipment by doing custom work. Still others had jobs where they could work at the time and intensity of their own choosing, for example, selling fertilizer or real estate. Of the growers with less than 20 acres of bearing peaches who were interviewed, about 50 per cent did some off-farm work. Almost no growers with more than 20 acres were working off-farm.

Another alternative which some peach growers might want to consider is selling the orchard, investing the capital elsewhere, and taking off-farm employment. If a grower has 100 per cent equity in his business and this capital could be invested elsewhere at the interest rates used in this study (6 per cent for land and 7 per cent for machinery), he might improve his income by doing so. Table 9 shows the profit (return to management) from peach orchards of different sizes and for different yields and peach prices. Thus, adding the value of the operator's labor to the figures in table 9 will show the return for the operator's labor and

management. If the profits in table 9 (plus value of operator labor) are less than the earnings from the nonfarm job, the operator would increase his income by selling out, reinvesting his capital, and taking the nonfarm job. Investigation of table 9 in this light shows that: (1) Growers with low yields (regardless of size) would improve their economic positions by selling out. (2) Even at high yields, growers with operations smaller than approximately 20 to 50 acres (depending on the price for peaches) would be better off financially to sell out. (3) With medium yields, relatively high prices and large acreages are necessary to make peach raising as profitable as selling out and working elsewhere.

Obviously, these statements are based on rather strict assumptions which in practice vary considerably from case to case. Per cent equity in the farm business, capital gains taxes, availability of off-farm work, off-farm wage rates, opportunities for capital investment outside agriculture and other factors all interact to determine the economic decision in each case. However, the analysis indicates that profit margins in peach production are sufficiently low to make other alternatives worth considering. The difficult decision of whether to sell out can best be brought into focus by budgeting out the alternatives for the situation in question.

Diversification Opportunities

It is sometimes recommended that producers diversify their operations by raising two or more crops to even out fluctuations. Diversification as a way of reducing income variability is successful only when the incomes from the crops are uncorrelated or, preferably, have a negative correlation; that is, the low income from one crop is offset by a high income from another.

One possible method of diversification is to raise cling peach varieties which mature at different times. For example,

Table 13. Correlations of Yields Per Acre Among Variety Groups in the Marysville-Yuba City and Modesto Areas[a]

Variety group	Correlation of variety groups							
	Marysville-Yuba City area				Modesto area			
	Extra early	Early	Late	Extra late	Extra early	Early	Late	Extra late
Extra early...	1.00	.90	.80	.13	1.00	.79	.69	.65
Early.........	....	1.00	.98	.22	....	1.00	.90	.97
Late..........	....	....	1.00	.36	....	....	1.00	.91
Extra late.....	....	....	....	1.00	....	....	....	1.00

[a] Based on 1953–60 yields per acre reported by maturity groups for Marysville-Yuba City district and Modesto district in: Cling Peach Advisory Board, *Orchard and Production Survey*, Annual Reports, 1953–54 to 1960–61.

particularly in the Yuba City-Marysville area, early rains occasionally have reduced yields sharply on the varieties being harvested at the time of the rain, without affecting yields from other varieties seriously. However, table 13 shows a high positive correlation in yield per acre among seasonal varieties in both the Marysville-Yuba City and Modesto areas. A correlation coefficient can theoretically range from –1.0 (perfect negative correlation) to +1.0 (perfect positive correlation). The generally high positive correlations of table 13 indicate that the yields per acre of the different varieties are highly associated; that is, they tend to move up and down together. (Variation in income per acre among varieties would also be highly associated because price is

constant among varieties.) While a range of varieties is desirable for reasons stated earlier, diversification by adding varieties holds limited promise as a means of reducing income fluctuations.

Another possibility for reducing income variability is to diversify by growing cling peaches in combination with other tree fruit and nut crops. Table 14 indicates the correlation of gross income per acre from cling peaches with the gross income per acre of each of the other major fruit and nut crop possibilities in the two primary cling peach areas of the state. Once again, the possibilities for reducing income variablity are rather discouraging. While the correlations of the original data are generally positive but low, the correlations of the first dif-

Table 14. Correlations of Gross Income Per Acre Between Cling Peach and the Other Major Fruit and Nut Crops in the Marysville-Yuba City and Modesto Areas[a]

Area	Series	Income correlation with cling peach crop							
		Plums	Prunes	Almonds	Walnuts	Apricots	Freestone peaches	Raisin grapes	Wine grapes
Marysville-Yuba City..	Original data........	0.10	0.22	0.24	0.36	....	....	....	....
	First differences[b]....	0.59	0.62	0.75	0.72	....	....	....	....
Modesto area..........	Original data........	....	....	0.44	0.35	0.19	0.24	−0.10	0.08
	First differences[b]....	....	....	0.63	0.80	0.50	0.66	0.13	0.63

[a] Data from: Sutter County Agricultural Commissioner Annual Reports, 1945–1959, and Stanislaus County Commissioner Annual Reports, 1944–1959.
[b] First differences are year-to-year changes.

ferences[19] show that year-to-year changes in income from cling peaches are generally associated with similar movements in the incomes of the other fruit and nut crops grown in the areas. Only raisin grapes appear to be a promising candidate as a diversification possibility in the Modesto area. None of the alternative tree crops is an attractive diversification prospect in the Marysville–Yuba City area. Apparently weather conditions, price changes and other uncertain variables affect most of these alternative crops similarly. The income of a producer in these areas probably would be nearly as stable if he specialized in cling peaches as it would be if he diversified with additional tree crops.[20]

PEACH GROWERS' OPINIONS OF OPTIMUM SIZE

The foregoing analysis of economies of scale can now be compared with the subjective views of peach growers as to efficient size of unit. The following two questions were posed to the sample of growers:

1. How many acres do you feel you will need in the future (next ten years) in order to operate efficiently?

2. How many acres could you operate with your present major machinery and equipment?

The responses of growers are grouped according to present size of operation and summarized in table 15. Several tentative conclusions appear justified from examination of the responses made.

1. Peach growers, particularly those with small acreages, are well aware that their operations are now or will be of insufficient size in the near future. Farmers in every size group less than 100 acres expressed a need for substantial increases in size in order to operate efficiently in the next ten years.

2. Peach growers with operations between 60 and 100 acres felt that they needed even larger acreages to operate efficiently in the future, despite the results of the foregoing analysis which indi-

[19] First differences are the changes in data from year to year.

[20] Diversification by adding field crops or livestock is not a practical economic alternative in most areas of the fruit districts considered.

Table 15. Opinions of Thirty-One Yuba City-Marysville Peach Growers Regarding Efficient Size in the Future and Capacity of Present Equipment[a]

Number of farms per size group	Present acreage		Efficient acreage in the future (question 1)		Acreage present equipment will operate (question 2)	
	Range	Mean	Range	Mean	Range	Mean
15	0–20	14	8–100	44	25–100	50
7	20–40	30	34–100	62	40–170	79
1	40–60	58	100	100	100	100
5	60–100	77	50–200	142	100–150	150
3	> 100	466	400–415	408	415–640	552

[a] Based on 1959 survey by authors.

cates few cost economies beyond 60 acres. However, many growers were anticipating mechanization in the next ten years.

3. The operations over 100 acres are apparently large enough to operate efficiently in the future without further expansion. The management saw little need to expand for efficient operation.

4. Smaller peach farms have large excess capacity in machinery. For example, farms averaging about 14 acres had suffi-

cient equipment for about 50 acres of peaches; farms of 30 acres had machinery capacity for 79 acres. The largest farms were apparently operating their machinery at near capacity.

5. The capacity of growers' present equipment was closely associated with expected future size of efficient operation, suggesting that growers recognized the need to use machinery to near capacity for an efficient operation.

APPENDIX A. COST CURVES FROM REGRESSION ANALYSIS

In this appendix the cost curves derived by regression analysis directly from actual farm observations are compared with those synthesized in the text using budgetary analysis. The observations are from a sample of farms obtained in 1959, based on the 1958 crop year. Several adjustments were made in the sample observations before fitting the regression equation. First, because of a wide variation in proportions of bearing to nonbearing acres in the sample, all farms were adjusted to their actual bearing acreage plus 20 per cent additional acreage in nonbearing trees. This adjustment put the analysis on the same basis as the budgeted curves in the text, and required corresponding adjustments in labor and variable cash expenses. Second, the interest rates and methods of depreciation varied widely from farm to farm and were consequently standardized, using the same rates for land, machines and trees as in the budgeted curves in the text.

The importance of yield per acre as a determinant of costs has been emphasized in the text. Hence, in Equation (1), total costs (C) were assumed dependent on two variables: Total tons marketed (T) and yield per acre (Y). The t-ratios of the coefficients are given in parentheses. The coefficients have the expected signs and are

$$(1) \qquad C = 307.2357 \qquad T^{0.9458}_{(32.7)} \qquad Y^{-0.5054}_{(3.1)}$$

$$R^2 = 0.98$$

statistically significant at the 1 per cent probability level. Equation (2) expresses the total cost function of (1) as an average cost curve. Equation (2) is then plotted out

$$(2) \qquad \frac{C}{T} = 307.2357 \qquad T^{-0.0542} \qquad Y^{-0.5054}$$

in figure A-1 for each of the three yield levels assumed in the text. These cost curves can be compared with the appropriate cost curves of figure 3 in the text (no green drop).
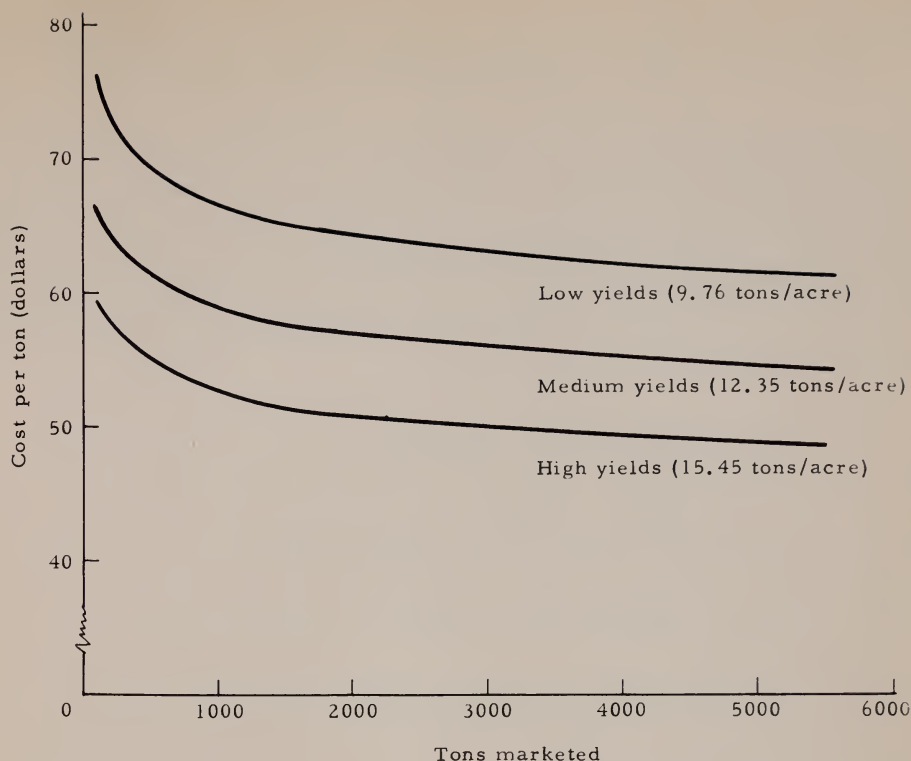
Fig. A-1. Average total cost per acre, Yuba City peach farms, based on
regression analysis of farm observations

The comparison shows that the general level of costs in the two cases is quite comparable. At the largest size considered (5,500 tons harvested), the comparative costs per ton between the budgeted and regression analyses are as follows: low yields, $64 versus $61; medium yields, $53 versus $54; high yields, $46 versus $48. Thus, the actual farm data (regression analysis) indicates that the effect of yield per acre on costs is still substantial, but perhaps slightly less important than suggested by the budgetary analysis. The main difference in the results of the two analyses is that the analysis of actual observation (regression) indicates greater economies of scale as size increases. In part, this is probably a result of the mathematical form of the cost function fitted. However, it also reflects the substantial overinvestment (or unutilized capacity) in machinery evident on the small farms. In the synthesized cost functions in the text, the machinery investment on the small farms was fitted more exactly to requirements than is often the case in practice. In summary, this supplementary analysis suggests that as farms are actually operated, there may be slightly more opportunity for reduction in unit cost as size expands than shown when units of all sizes are assumed operated at maximum efficiency.

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APPENDIX B. METHOD OF CALCULATING ALLOWABLE PER CENT LOSS FROM MECHANICAL HARVESTING

To simplify the problem of finding the amount of allowable loss from mechanical harvesting, mathematical long run cost functions were synthesized for the nonmechanized and mechanized situations.[1] In each situation the long run cost curve is best approximated by segmenting into two functions—one for farms smaller than a given size and another for farms larger than this size. Equations (1) and (2) are long run cost functions for nonmechanized farms of 20 to 60 acres and over 60 acres, respectively. Equations (3) and (4) are long run cost functions for mechanized farms of 20 to 86 acres and over 86 acres, respectively. A 15 per cent green drop is assumed throughout.

$$(1) \qquad C_{nm_1} = \frac{412 + 307A + 182WA}{T} + 9.25W + 4.10$$

$$(2) \qquad C_{nm_2} = \frac{293A + 208WA}{T} + 9.25W + 3.66$$

$$(3) \qquad C_{m_1} = \frac{2{,}712 + 334A + 106WA}{T} + 4.35W + 4.24$$

$$(4) \qquad C_{m_2} = \frac{358A + 104WA}{T} + 4.35W + 3.66$$

The variables are defined as follows:
A = acres (bearing + nonbearing)
T = tonnage available for harvest (before losses from mechanical handling)
W = wage level (1.0 = original wage level; 1.5 = 50 per cent increase, etc.)

$$C_{nm_1} = \text{cost per ton, nonmechanized, 20 to 60 acres}$$

$$C_{nm_2} = \text{cost per ton, nonmechanized, over 60 acres}$$

$$C_{m_1} = \text{cost per ton, mechanized, 20 to 86 acres}$$

$$C_{m_2} = \text{cost per ton, mechanized, over 86 acres}$$

The allowable loss from mechanical harvest is defined as that loss which can be sustained using mechanization and still provide the same level of profit for a given farm situation as using nonmechanized methods. Letting T' equal the tonnage available for sale from mechanical harvesting and P equal price per ton, this break-even profit condition is defined in Equation (5). The per cent of allowable loss (6) is then entered in table 11 in the text.

$$(5) \qquad T(P - C_{nm}) = T'\left(P - \frac{TC_m}{T'}\right)$$

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[1]Nonmechanized refers to present practices. Mechanized refers to the type of mechanical pruning, thinning, and harvesting described in the text.

$$(6) \qquad \left(\frac{T - T'}{T}\right) 100 = \text{per cent allowable loss}$$

The procedure can be summarized as follows: Select the acreage (A), associated tonnage (T) depending on yield level, and wage level (W) of interest. Using the appropriate cost functions (depending on size of farm in acres), compute the cost per ton from nonmechanized handling (C_{nm}) and from mechanized handling assuming no loss (C_m). Then for the desired peach price (P), solve (5) for T' and (6) for per cent of allowable loss.